MASTERCALC

SOFT 905 (Cassette)
SOFT 1905 (Disc)

Published by **AMSOFT**, a division of

Amstrad Consumer Electronics plc
Brentwood House
169 Kings Road
Brentwood
Essex

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First Edition 1985

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CONTENTS

What is a spread-sheet? 1
Some concepts introduced 1
Summary of MASTER-CALC features 2
Conventions 4
Loading MASTER-CALC 5
MASTER-CALC tutorial 6
MASTER-CALC top menu 16
- New plan 16
- Load a plan 16
- Save plan 17
- Catalogue 17
- Resume plan 17
- Tape and Disc switching 17
- Set colours 18
- Exit to BASIC 18

Summary of display options 19
Cursor movement 20
Window movement 20
Window split 21
Mode change 21
Entering numeric data 21
Entering text 22
Repeating data 22
Clearing data 23
Spare memory space 23
Inserting/erasing a row or column 23
Altering column formats 24
Giving the plan a title 25
Computed data: totals 26
Computed data: formulae 26
How to enter a formula 28
Altering and erasing a formula 28
How to use a formula 29
Where to use a formula 29
How to see which cells are computed 29
How to display a formula 30
Graphic histograms 30
Screen Snapshot 32
Printed output 32
Re-calculation of computed values 34
Numeric overflow 35
Very small numbers 35
Negative numbers 36
Apparent arithmetic discrepancies 36
Program back-up and file transfer 36
File structure 37

What is a Spread-Sheet?

A spread-sheet is a piece of paper on which numerical information is written in order to help one see what is happening to a business or process. It is usually divided into rows across and columns down, and often includes totals and other values computed from the entered data, with the object of making the information more comprehensible.

A financial balance sheet is a kind of spread-sheet. Another example is a sales performance chart. Another is a household budget. Many uses of a spread-sheet show information measured weekly or monthly, each column of figures being associated with a particular time period.

Figures alone are not easy to digest, so a spread-sheet is usually annotated with headings and other pieces of text, especially to label the rows and columns of data.

The main problems with paper spread-sheets is that they are prone to human error in calculating totals and balances, and any amendment to the figures involves tedious work.

An electronic spread-sheet, such as MASTER-CALC, lets the computer do all the hard work of arithmetic. Indeed, so easy is it to re-work data on the computer, the electronic spread-sheet is today used in ways where paper versions were seldom used; in simulation, planning, projection. The more usable spread-sheet programs also allow the numbers to be converted into graphic charts for even better visual impact.

Financial models especially benefit from spread-sheet treatment, since the computational aspects of inflation accounting, discounted cash flow, fluctuating exchange rates and interest rates, are simple for the computer, daunting for man.

Some concepts Introduced

The electronic spread-sheet has just one disadvantage compared with the sheet of paper; the computer screen cannot show the entire sheet except for the smallest of plans. But this does not limit the program, since the screen is used as a 'window' through which to view any part of the greater plan. However, what started as a disadvantage becomes an advantage, since the computer can handle a plan rather larger than would be practical on a single sheet of paper.

In order to 'navigate' around a plan, a co-ordinate system is used, just as one finds with maps. Thus every row and column is given a number, and each 'cell' is uniquely identified by its row number and column number. For the purpose of moving our screen window and for relating information, we use this numbering system. With MASTER-CALC, the top left corner of a plan is row 1 column 1. Our program shows row numbers down the left side of the window, column numbers across the top, in reversed colours.

The intersection of a row and column is called a 'cell' and each cell can hold a number between 0 and 9,999,999,999,999,999 (+ or -). Alternatively, a cell can hold text, for use as an aid to comprehension. With MASTER-CALC any cell can be used for either purpose.

Within the window, the currently-accessed cell is highlighted with reversed colours. We call this the 'cursor'. Thus before entering information, the cursor is positioned to the target cell.

Numbers may be computed rather than simply entered. Computations are effected either by using one of the MASTER-CALC total functions, or by defining a formula. A formula specifies some numerical relationship between cells, for example showing one cell as the percentage of two other cells.

MASTER-CALC offers great flexibility in the way in which numbers are to be displayed. Perhaps simple integer format is ideal for most plans, but up to 7 decimal places are possible. All numbers are computed and held to the highest precision, and displayed rounded to match the number of decimal places required. Further, there is the option to insert commas every three digits.

Unlike many less capable systems, MASTER-CALC lets you choose the display style individually per column, and one can also have varying column widths on the screen. Thus for example, extra room can be given to labels and row totals. Column formats can be altered at any time without loss of data.

Plans can be saved to cassette or disc for later use.

Summary of Master-Calc Features

* Large capacity, room for up to 3,000 cells, e.g. 100 rows x 30 columns.
* High precision, all values stored internally as 8-byte floating point.
* Direct totals and sub-totals by row or column.
* Up to 99 formulae, each allowing complex arithmetic expressions.
* Unique formula portability, use the same formula in many places.
* Insert or erase a row or column.

* Text can be keyed directly, anywhere on the plan.
* Numbers can be displayed as integer, or up to 7 decimal places. Rounding is done at the last moment.
* Numbers can optionally include x,xxx,xxx commas.
* Columns can be tailored individually or in ranges, in respect of screen width and numeric format.
* Display range is ± .0000001 to 9,999,999,999,999,999.
* Intermediate computation range is approximately 10 to the ± 38.
* Plan can be overlaid by column, i.e. the window can show columns not normally close enough to share the screen.
* Window can be split into two, upper and lower, which can then be manipulated independently.
* Plan can be switched between 40-column and 80-column display.
* Option to auto-advance to next cell across or down after entry of data.
* Repeat-last-value facility.
* Printed hard-copy with many slice-up options; can send control codes to the printer. Up to 240-column printer width is allowed.
* Instant highlight of all computed fields.
* Graphic histogram of 1,2 or 3 row variables, with fully automatic range trim and raised baseline to accommodate negative values.
* Colour trim.
* Load/save plan.
* Use cassette or disc.
* Instant access to main menu of options.
* MASTER-CALC is fully machine-coded for speed and compactness.

Conventions

When MASTER-CALC offers a menu or prompt message it will respond equally to keys in lower case or upper case. However, in this manual we describe all menu responses in upper case, for clarity. Thus when we say 'use R' we do not require that **SHIFT** or **CAPS LOCK** be used before you press the **R** key.

Where we use square brackets, this means 'press the key marked with this word'. Thus **[ENTER]** means 'press the **ENTER** key'.

Apart from the top menu, concerned primarily with starting and terminating a work session, MASTER-CALC communicates through prompts shown near the bottom of the screen - although there is also a 'main menu' option which uses the whole screen. The prompts are generally of two kinds: those which require text terminated by **[ENTER]**, and those which respond to just a single key.

Where text is required, a cursor is offered, and your response can be edited as you go.

Single-key responses are either Y/N, waiting for **Y** or **N** key, or they offer a list of words from which you choose by pressing the first letter. For example, one of the prompts is:

```
TOTAL: Row/Column/Accum
```

which accepts **R** or **C** or **A** by way of response.

Where a single key is awaited, there is no cursor.

In most cases, **[ESC]** key can be used to 'back out', which means that you have changed your mind. This option is implicit, i.e. it is not a listed option.

In some cases, **[ENTER]** is also a 'back-out', in other cases it may be taken to mean 'please take a default action'. In a few cases, any unprompted key is taken as a 'back out' - where we thought that it was more friendly to do so.

Loading Master-Calc

If the computer has been used for another program, reset it via **[CTRL]/[SHIFT]/[ESC]**.

From tape: `RUN"` or `RUN"MCALC"` **[ENTER]** and play the tape.

From disc: `RUN"MCALC"` **[ENTER]**.

From tape but with disc interface connected:

```
ITAPE [ENTER]
RUN" or RUN"MCALC" [ENTER]
```

A short BASIC program loads first, which in turn loads the main machine-code program of MASTER-CALC.

The next chapter of this manual is a detailed tutorial which introduces many, but not all, of the MASTER-CALC functions. All but the most seasoned spread-sheet users are advised to follow this tutorial.

Master-Calc Tutorial

Introduction

In this tutorial we will build a modest spread-sheet to analyse the profitability of a hypothetical computer dealer. We will tabulate monthly sales by three product areas, and expenses into two types. The idea is to show the monthly and cumulative profitability - or lack of it. This is perhaps a rather simple breakdown, but serves well to introduce the functions of MASTER-CALC.

We will plot time horizontally - as is usual - and each column will show a month's data. For 12 months we need 12 columns. But we also need a left-most column for labels, and a year total column at the right, making 14 in all. As for rows we need two for headings, five for sales and expenses, two totals rows, a computed profit row, and a few extra rows for grouping purposes - say 15 rows in all. We can always insert extra rows or columns later if we need them.

Starting up

With these dimensions in mind, we can now load MASTER-CALC. From tape use:

RUN" [ENTER]

From disc use:

RUN"MCALC" [ENTER]

When the top menu appears, press N to initiate a new plan. Then supply the dimensions as prompted: rows = 15, columns = 14. The plan is then displayed, up to column 9. (See Fig.1) Columns 10 onwards are for now not visible.

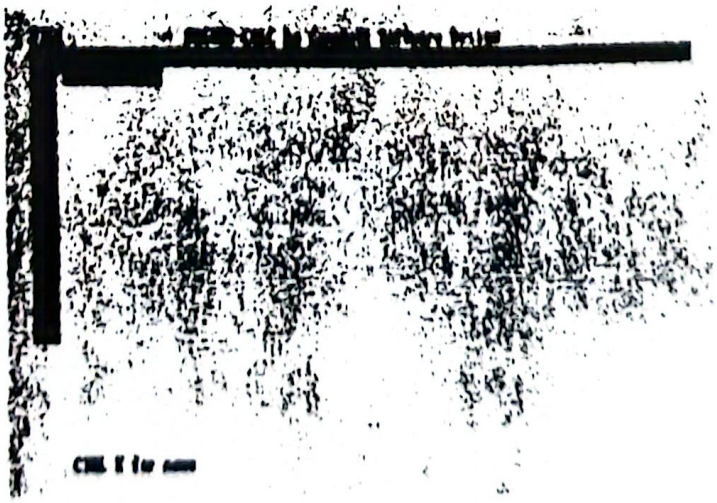

Fig 1

Try the steering wheel

Use the four arrow keys - singly - to steer the cell cursor around the window. Notice that column 1 is wider than the other columns.

Now try **[SHIFT]** with right-arrow, and see how the window shifts to the right to show the remaining columns, although column 1 remains in view. Use **[SHIFT]** and [←] left-arrow to shift the window back again. **[SHIFT]** and up/down arrow does nothing with this plan, because all rows are already spanned by the window. Note that arrow keys alone move the cell cursor within the window, whilst with **[SHIFT]** the window itself moves around the plan - given room.

There are other cursor/window functions for you to explore, but already you have used all those you need for this tutorial.

A quick look at the controls

Near the bottom of the screen you will see 'CTRL K for menu'. This is a reminder that a list of your display options can be viewed. Try it: press **[CTRL] K**. This is a little easier than reaching for the manual. Now press **[ENTER]** to resume our still-empty plan. Now press **[CTRL] S** to see how many spare bytes there are - of course there is plenty of unused RAM with this small array.

Headings

We will put month headings along the top, as follows. First, move the window to its start position, if not already there. Then steer the cursor to row 1 column 2 where we will start entering text. Press **[SHIFT] 2**. (double quote), when you then see 'Enter text at cursor' at the bottom of the screen. Now, anything you key will be written into the cursor cell as text. You will be keying spaces, hard to show here, so we will indicate a space with a dot as follows:

```
...Jan.....Feb.....Mar.....Apr.....May.....Jun.....Jul.....Aug[ENTER]
```

[ENTER] signalled 'end of text', and note that we were able to enter text into a series of cells without breaking in between. But we cannot go over the window edge; instead we now use **[SHIFT][→]** right-arrow to shift the window. Do this then enter the remaining months from column 10 onwards. **[SHIFT] 2** and:

```
...Sep.....Oct.....Nov.....Dec.....Year[ENTER]
```

Now to put dashes throughout row 2 to underline the headings. Press L to take the cursor to the left, then down-arrow to row 2. Press **[SHIFT] 2** to start text entry then hold the minus-sign key down to enter dashes all the way across the window. Press **[ENTER]** when right edge is reached.

Next, **[SHIFT][←]** (left-arrow) to reposition the window to the left of the plan, and do the same again, filling row 2 with dashes. Remember that when the right edge of the window is reached, you must press **[ENTER]**.

If you make a mistake, **[DEL]** is a delete-and-backspace, but only within the current cell cursor. But you can always re-fill an individual cell with corrected text later.

That takes care of the column headings, so now we will put in the row headings. Steer the cursor to row 3 column 1.

Press **[CTRL] D** which should cause a down-arrow to appear in the bottom left of the screen. This is a reminder that we have turned on auto-cursor-advance, which means that the cursor will advance to the next cell after entering text or data.

[SHIFT] 2 and key the heading:

`Computers` **[ENTER]**

The cursor will advance to row 4 by itself. Now **[SHIFT] 2** and:

`Peripherals` **[ENTER]**

In row 5 use **[SHIFT] 2** and:

`Software` **[ENTER]**

Press **[ENTER]** again to skip a row. (When auto-advance is active, the **[ENTER]** key acts as if the right or down arrow has been pressed, depending on the direction of the indicator arrow at bottom left of the screen.)

Then in row 7, **[SHIFT] 2** and:

`Total sales` **[ENTER]**

In similar fashion, enter heading 'Direct costs' in row 9, 'Ind. costs' in row 10, 'Total costs' in row 12, 'Gross Profit' in line 14. Your plan should now look like Fig.2.

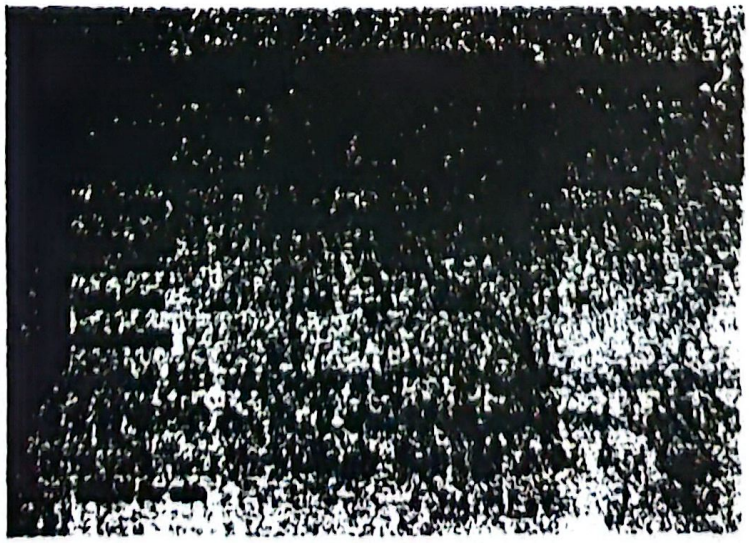

Fig 2

Any slips ?

If you make any slips such as forgetting to prefix text with **[SHIFT] 2**, you may accidentally invoke other functions, or even enter values. Do not panic, you are unlikely to do any damage.

If for example you intend to enter 'Computers' and forget the **[SHIFT] 2**, then command C invites '`Give column number`'. Just 'back out' using **[ESC]** key, and try again. Likewise 'Software' begins with S, so if you have not started with **[SHIFT] 2** the screen splits into two windows; just use S a second time to revert to single-window.

If you press 2 without the **[SHIFT]** key, you may find yourself entering a data value. Back out with **[ESC]** if you have not yet pressed **[ENTER]**. If **[ENTER]** has already put the erroneous value where you wanted text, then you will have to undo the damage by clearing the cell. Use **[CTRL] Z** then **E** to clear the cursor cell of unwanted text or data.

Entering the primary data

Place the cursor at row 3 column 2 (i.e. Computer sales for January), and press **[CTRL] R** to set auto-cursor-advance right. Observe the indicator in the lower left corner of the screen. It should show an arrow pointing right. If not, press **[CTRL] R** a second time. (It is a 'toggle' function.)

Press the 4 key. Immediately, the prompt appears:

```
Value:4
```

Finish the value with **300 [ENTER]**. The value 4300 then transfers to the cursor cell. MASTER-CALC instantly senses a number (or decimal point or sign) so that entry of values into a plan is very direct. There is no prefix to say 'I want to enter data', as there is with text entry for example.

The cursor will have advanced to column 3, ready for you to enter February computer sales. Do so, and we suggest you enter any four-digit number in each month up to the edge of the window, which is column 9, August.

You can shift the window right and complete the entry of data up to December, but it may be easier to enter the rest of the data for the current window first. You choose what you want to do, and one way or another enter pretend figures for rows 4,5 and 9, up to column 13 in each case.

Row 10 is 'Indirect costs' and often in business these are more or less constant; let us pretend that this is so for our plan. Enter the value 2500 at row 10 column 2. Ensure the auto-advance-right is set, use **[CTRL] R** if necessary. Now hold down **[SHIFT] 6** and watch as the last entered value is repeated right across the window. Shift the window and use **[SHIFT] 6** to fill in row 10 for the rest of the months. Your plan should look like Fig.3.

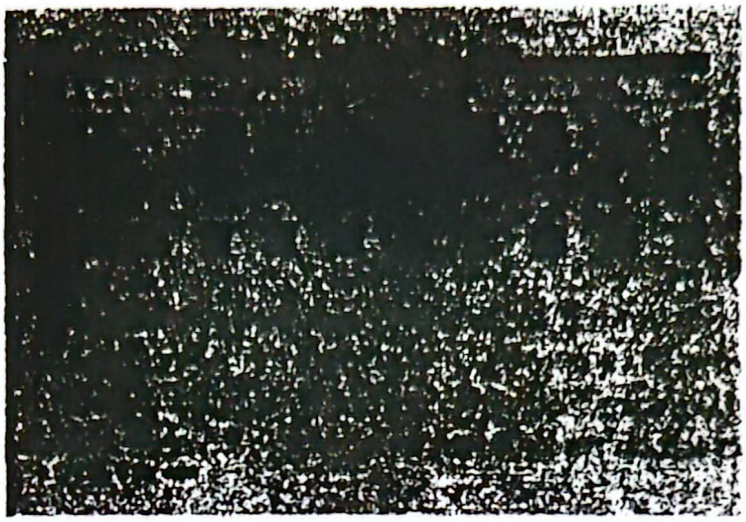

Fig 3

Column totals

So far all the data entered has been keyed by you. Now we will ask MASTER-CALC to do some work, and compute various totals. Place the cursor at row 7 ('Total Sales') column 2 (January). We will ask the program to give the total of all values stored above in the same column. Press **T** which yields:

```
TOTAL: Row/Column/Accum
```

Press C to indicate we are totalling vertically. You then see:

```
Sub-total/Full total
```

Although a sub-total will give the same answer as a full total in this position, the most logical choice is sub-total, so press S. Immediately, the three values in rows 3,4,5 are totalled and the answer stored where the cursor was. The cursor itself will have advanced, and you can repeat the sequence TCS TCS etc all across the window.

Now position the cursor to row 12 column 2, and again use a series of TCS responses to generate the sub-total monthly costs.

Reposition the window to access the remaining months and repeat the sub-total procedure.

Row totals

So far your column 14 should be empty from row 3 downwards. Now we will ask the program to compute the 'Year-to-date' row totals. Position the window to show column 14 and place the cursor at row 3 column 14. Toggle the auto-advance to the downwards direction, via **[CTRL] D**. We want a full row total, so we press **T** then **R** then **F**. Instantly the row-total is computed and stored, and the cursor will be positioned to the cell below. Press TRF and TRF to compute rows 4 and 5. Press **[ENTER]** to skip row 6 then TRF in row 7. Use TRF in rows 9,10,12 and 14.

Your plan should look like Fig.4.

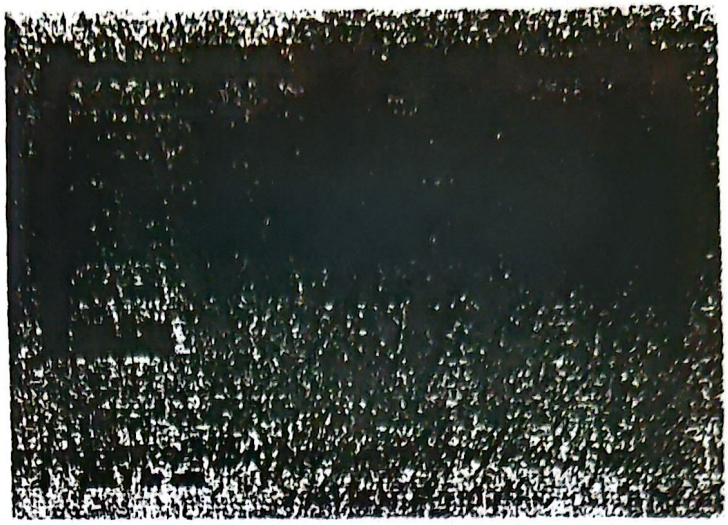

Fig 4

A Formula for profit

Our plan is nearly completed, and we just need to compute the profit line which is row 14. For this we need a FORMULA, to compute gross profit as being total sales minus total costs. Looking at the plan we observe that row 7 holds total sales, and row 12 holds total costs. Our formula should therefore look something like:

Row 7 - Row 12

In fact the formula is: r7-r12

The 'r' in the formula means 'row'. We do not specify a column reference in this example, since MASTER-CALC's unique Portable Formula system works by taking the unspecified reference from wherever the formula is used. This will become clearer as we proceed with the formula exercise. Read on.

Press [CTRL] F which shows the prompt:

```
FORMULA: New/Amend/Erase
```

Press N because we want to supply a new formula. Now, every formula must be given a reference number, by which cells can refer to it. Any number 1-99 may be used, but it is tidiest to start at 1, then 2 etc. You will be asked:

```
Formula number 1-99:
```

Press 1 **[ENTER]**. You are then asked for the formula itself:

```
Enter new formula...
```

You key: `r7-r12` **[ENTER] [ENTER]**

The formula is now stored, but not yet used. Position the cursor to row 14 column 2, and set auto-advance-right. Now ask MASTER-CALC to use formula number 1 at the current cell, as follows. Press F. You are then asked:

```
Formula number 1-99:
```

Press 1 [ENTER]. Immediately, the computation is made and the result displayed where the cursor was. The cursor itself has moved on, and you can repeat the same sequence of F1 [ENTER] until the right edge of the window is reached. Shift the window and fill in the remaining monthly profits in similar style.

Formula Portability

The same simple formula we have used in every data column. To remind you what the formula is, position the cursor over any gross profit value and press [CTRL] F. The formula is displayed at the bottom of the screen:

```
FORMULA: New/Amend/Erase
1:r7-r12
```

(Press [ENTER] to back out of the New/Amend/Erase options.)

When this formula is used in column 2 it behaves like 'row 7 column 2, minus row 12 column 2', and indeed we could have used the formula:

```
r7c2-r12c2
```

But our portable formula when used in any other column takes the column from the where it is used, so that in column 3 it behaves like:

```
r7c3-r12c3
```

Use portable formulae wherever possible.

Which cells are computed ?

This is a useful to know, and MASTER-CALC tells you at once when you press [CTRL] T. Do this now. Every computed cell in the window is high-lighted with a short legend saying how it was computed. For example, rows 7 and 12 will show 'CST' meaning 'Column Sub-Total'. Column 14 shows 'RT' meaning 'Row (full) Total'. And row 14 shows 'F01' meaning 'Computed via formula number 1'. Press any key now, to clear the high-lights.

Re-calculate

So far, row 14 column 14 shows zero, since row 14 had no data when we specified that 14,14 was to be a row total. To make MASTER-CALC recalculate all total and formula cells, press [CTRL] C. Do so now. If you are very alert, you may note the legend:

```
--- Calculating ---
```

at the bottom of the screen. But blink and you miss it. The window is re-drawn showing any changes. Try altering some of the primary data (i.e. values which you entered), then [CTRL] C and observe the new computed values.

Try adjusting some figures, if necessary, to yield negative profits in one or two months. **[CTRL] C** after any changes.

A slimming diet

If it is important to be able to see all 12 months together in one window, then our columns need to slim down. Let us reduce the widths of columns 2-13 from their initial width of 8 characters, down to 6. Press **[CTRL] A** and this gives:

```
ALTER: array size Y/N
```

Press **N**, which gives:

```
Width/Dec.pl/Commas/Title
```

Press **W**, because we wish to change column display widths. Then:

```
From column...:
```

Reply **2 [ENTER]**

```
...To column:
```

Reply **13 [ENTER]**

```
Width (4-24):
```

Reply **6 [ENTER]**. Now the dialogue ends and the screen is re-drawn with the columns reduced in width to 6 characters.

Press **L** then **O** (letter Oh) then **2 [ENTER]**. You will now see that although we have lost the column 1 labels from the window, we now have all twelve months in view. Your plan should now resemble Fig.5.

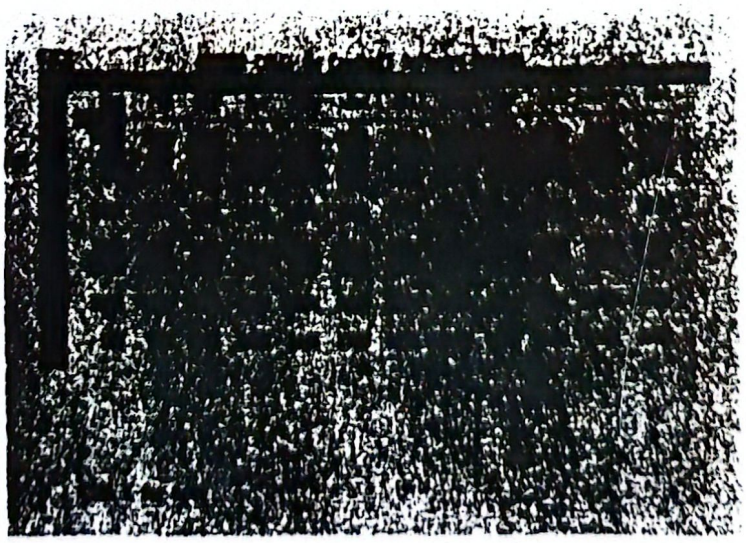

Fig 5

This is a good time to show a chart; read on.

A picture is worth a thousand figures

With columns 2-13 in view, press **[CTRL] G**. You are asked:

```
Give 1st row to plot:
```

Reply **14 [ENTER] [ENTER]**. Behold, your monthly profits are shown graphically. This is called a histogram. Negative values (did you have any ?) are shown as downward bars. (See Fig.6.)

```
Another ? Y/N
```

Now press **Y** to indicate another chart, and this time reply to the 'rows to plot' prompts with **3 [ENTER] 4 [ENTER] 5 [ENTER]**. Now you can see the relative sales of the three product lines. (See Fig.7.)

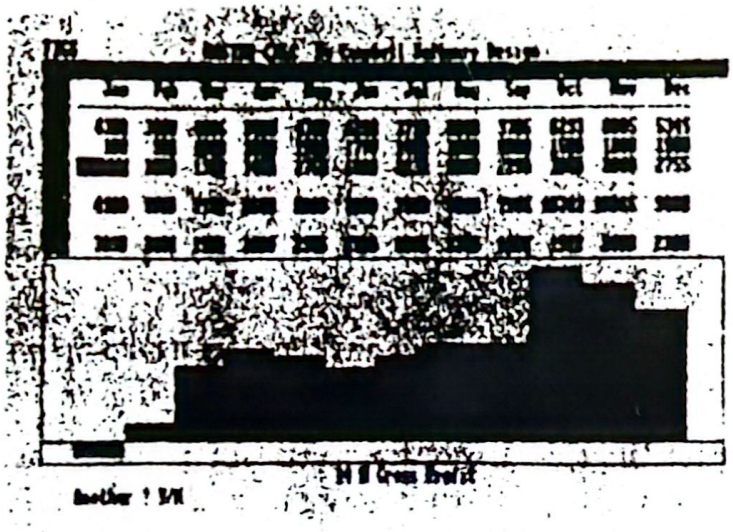

Fig 6

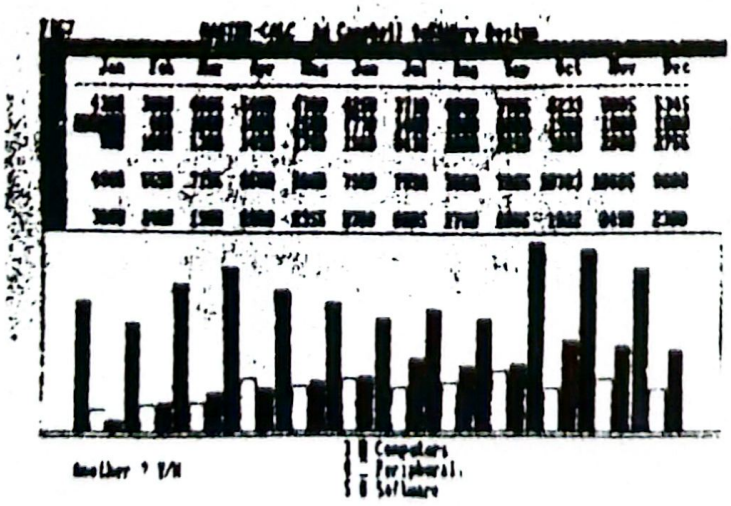

Fig 7

Experiment with other row numbers and combinations. To finish, press **N** in response to:

```
Another ? Y/N
```

Hard copy

If you have a printer attached, switch it on and ready it. Position the window to include column 1 again, via **[CTRL] H**. Then use **[CTRL] P** to start the printing dialogue. You will be asked:

```
PRINT: row/col numbers to show Y/N
```

Press **Y**. More prompts will appear, but for now just reply with **[ENTER]** to each of them. This will make MASTER-CALC take default actions, and assuming yours is an 80-column printer you will be rewarded with an approximate screen copy. The printer layout is different in such details as the reference numbers and extra lines either side of the column numbers.

Save the plan for later

If you wish to save this plan for a later session, then press **[CTRL] X** to reach the top menu, which offers the save option. Press S and you are asked:

```
Give file name:
```

Place a cassette in the datacorder, unless you are saving to disc. Reply with a name of no more than eight characters, and press **[ENTER]**. On completion of the save, the plan display is resumed, with the filename shown at top left.

A few things to try all by yourself

Our plan is complete as far as it goes, but see if you can add an extra column, number 15. Clue: **[CTRL] A** then **Y** to start with. In the new column, show each product line as a percentage of the total sales. This will require another formula, as follows:

```
c14*100/r7c14
```

Use this formula in column 15 rows 3,4,5.

Columns 2-13 are still only 6 characters wide, but we left column 14 at 8 characters wide, room for a change of format. See if you can display the figures in coumn 14 to show 'thousands' commas. Clue: start with **[CTRL] A** again.

Assuming you managed to generate percentages in column 15, use **[CTRL] A N** etc. to convert these figures to show 2 decimal places.

Finally, use **[CTRL] A N** etc. to alter the plan title, as shown at the top of the screen. You can have your own title here, up to 40 characters long.

MASTER-CALC TOP MENU

When the program is loaded, the program name, version, and other headings are shown, together with the following menu (list of options):

```
N...New plan
L...Load a plan
S...Save plan
C...Catalogue
R...Resume current plan
T...Tape
D...Disc
*...Set colours
X...exit to BASIC
```

To select one of the above, just press the indicated key. However, selections S and R will not respond until a plan has been created or loaded. The options are described below.

N...New plan

This is how to initiate a new plan, and all that the program requires from you to start the plan are the number of rows and columns. You are asked:

```
How many rows:
```

Reply with a number in the range 5 to 230. Then you are asked:

```
How many columns:
```

Reply with a number in the range 5 to 230. But please note that the total number of cells is limited to around 3000; if you exceed this, MASTER-CALC warns with

```
Dimension error - ENTER
```

Once the program is given the valid dimensions, the new plan is shown with the window viewing the top left. The plan is ready to receive data immediately, or you may make use of the ALTER functions first to tailor the column widths and the display styles.

L...Load a plan

The alternative way to start a session with MASTER-CALC is to load a plan which was saved at an earlier session.

You are prompted for the file name:

```
Give file name:
```

Even for cassette, you must reply with the saved name. If you have forgotten then make use of the catalogue function first (Described below).

Once the plan is found and loaded, it is displayed with the same colours, formats, and window(s) that applied when it was saved.

S...Save plan

If you have made any changes to your plan then you will most likely wish to save it again, and this option is used. Of course, you must invoke the top menu first, if your plan is currently on display. To exit the display, use **[CTRL] X**.

You are prompted for the file name, but you may reply with just [ENTER] in order to use the same name as was already displayed at top left of the screen. But when saving a plan for the first time, give a name of up to 8 characters. Note that although CPC464 allows 16-character names for cassette, we limit you to 8 to be compatible with the disc system.

The plan will be saved on the currently selected device (see Tape and Disc functions below).

On completion of the save, the plan display is resumed.

C...Catalogue

Use this to see what is on tape or disc. (Use T or D as already described below in order to select device type if you have a disc system.)

The screen is cleared and `CAT` is issued. Please note that for tape use, this is 'endless' and is terminated only by **[ESC]** key.

Press **[ENTER]** to resume the top menu.

R...Resume plan

If a plan has been loaded or initiated, then this option simply returns to the display of the plan, with the same window arrangement as when it was last viewed. If there is no plan in the computer, this option is disabled.

T...Tape

This is for disc users who wish to switch to tape, and T is equivalent to the BASIC command: `|TAPE`

If no DDI interface is connected, then Bad command appears momentarily and the top menu is resumed, with no harm done.

D...Disc

This is for disc users who wish to switch back to disc use after using T...Tape, or in order to select drive A or B. Pressing **D** is equivalent to the BASIC command: `|DISC`

If no DDI interface is connected, `Bad command` appears momentarily. Otherwise, the program invites you to select the current drive:

```
Drive A/B
```

Press **A** or **B** as required, equivalent to BASIC commands `|A` or `|B`, or else back out with **[ENTER]** or **[ESC]**.

*...Set colours

Although MASTER-CALC does allow use of 40-column mode, it still only permits three colours: paper, pen, and border. You can select any ink colour for each of these by using the top menu [*] option. The following prompt appears:

```
COLOURS: Paper/Ink/Border
```

The convention with this kind of prompt is to reply with the first letter of the selected choice, in this case P or I or B. Upper or lower case are equally acceptable. Use any other key to terminate.

Please note that we have used the word 'Ink' here to mean 'Pen' in CPC464 terms.

Hold down **P** **I** or **B** to effect colour changes until the desired mix is found.

Exit with **[ENTER]** or any other key except **P**,**I**,**B**.

The colours stay in force - even to the extent that a saved plan when reloaded will resume its saved colours.

X...Exit to BASIC

This option is provided to allow you to use the BASIC environment for the purpose of making a back-up copy of the program.

Key X provides a list of the short BASIC program, then halts `Ready`.

To resume the top menu, use: `GOTO 100` **[ENTER]**

Do not give the commands `RUN` or `CLEAR`, since these will cause MASTER-CALC to lose track of available memory space.

Summary of Display Options

While a plan is displayed, there are many options available to you. We have made it very easy to enter data. In essence all you do is use the arrow keys to move the cell cursor around, and key your numbers directly -terminating each value with **[ENTER]**. To move the window around the plan, hold **[SHIFT]** and use the arrow keys. To enter text, position the cell cursor, press **["]**, then key the text and end with **[ENTER]**. Most of the time, these are all you need to build your plan.

MASTER-CALC offers many more functions than the basic ones just described. Usually, the legend 'CTRL K for menu' can be seen near the bottom left of your screen. Press **[CTRL] K** to see the full list of options. The list is available as a memory jogger, and you do not have to display the menu in order to use the functions listed. The list is as follows, loosely divided into single-key functions and **[CTRL]** functions.

```
Single-key...                    CTRL and key...

C..get column                    A..alter size/format
F..use formula                   C..recalculate
H..home in window                D..toggle auto cursor down
L..left in window                F..formula options
M..change mode                   G..graphic histogram
O..overlay at column             H..home in plan
R..get row                       K..show this menu
S..window (un-)split             P..print
T..define total                  R..toggle auto cursor across
W..window select                 S..show spare bytes
&..repeat entered value          T..show total/formulae usage
↑..top of window                 X..top menu, save/load etc
"..enter text                    Z..clear row/column/cell
(+-)number..enter value
↑ ↓ ←→..move cursor              SHIFT  ↑ ↓ ←→..move window
```

Some of the 'single-key' options require **[SHIFT]** key, but it is convenient to show the list this way.

Some of the functions listed in turn yield further options, for example **[CTRL] A** which invites you to insert or erase a row or column, set column display widths, set numeric styles, etc.

Read on for a description of each of the display options.

Cursor Movement

The arrow keys (around the **COPY** key) move the cell cursor around the window. When the edge of the window is reached, there is no further movement in that direction.

A quick way to the left-most edge of the window is **L**.

A quick way to the top-most edge of the window is ↑. (Next to **[CLR]** key.)

A quick way to the 'home' position, top left cell, is **H**.

Very often, when entering data in rows or columns, you will want to advance the cursor to the next row or column. MASTER-CALC will advance the cursor automatically if you first use **[CTRL] R** or **[CTRL] D**. This option acts in a 'toggle' fashion, and the current state of the auto-advance is reflected in the bottom left of the screen, where an arrow indicates the direction currently set. However, it cannot take the cursor beyond the window.

Window Movement

To move the window, use **[SHIFT]** and an arrow key. Note that the moved window still retains the left-most column and the two top rows, on the assumption that they contain textual labels which assist in identifying the information shown in the rest of the window.

[SHIFT] arrow generally moves the window so as to resume where the previous position left off. So if columns 1-9 are in view, shifting the window to the right will view columns 1 and 10,11,12, etc.

To position the window at a specific row or column, options R and C are used. In each case, you are asked for the target reference number.

To reset the window to the top-left 'home' area of the plan, use **[CTRL] H**.

Now for some advanced functions...

You can overlay in a vertical line so as omit intermediate columns. This is done by using O (letter Oh for Overlay). For example, if you have columns 1-9 currently shown, move the cursor to column 6, press O and give column reference 20 when prompted. The window is then re-drawn showing columns 1,2,3,4,5,20,21, etc., with columns 6 to 19 hidden from view.

The overlay function is useful for keeping a totals column in the window whilst you work on columns not otherwise able to share the screen. Another use for the function is to force the window to exclude column 1, perhaps in preparation for a full-width graph, or for printing purposes.

There is another window manoeuvre which merits its own chapter, next.

Window Split

Display option S divides the screen into two independent windows. Only one of these (the top one, initially) is active, characterised by showing a cell cursor. Option W switches from one window to the other. All the cursor and window movement functions as described in the previous section affect the current window without affecting the other. Thus we have a powerful method of keeping one part of the plan in constant view, whilst the other window can move about the plan.

Another advantage of using split windows is that window movement is faster. Moving a window requires the conversion of the cell values from binary floating point to readable ASCII, and rebuilding the screen - both relatively slow processes.

Option S is a 'toggle', so that if used a second time, the screen reverts to a single large window, extending what was the upper window.

It is possible to have the some cells shown several times on the screen by means of column overlap and split windows. Entering data into such cells does not cause the other images of the cell to be updated until the screen is re-drawn.

Mode Change

M switches the plan display from mode 2 (80-columns) to mode 1 (40-columns). It has a toggle effect, so that M again reverses the process.

Entering Numeric Data

With the cursor at the target cell, just key the number and **[ENTER]**. Any digit or plus, minus, period is detected as the start of numeric data, and causes the prompt 'Value: ' to appear, to solicit the rest of the value. Up to 16 characters of data are permitted. You can include commas, although they have no effect on the re-displayed value.

MASTER-CALC lets you enter values into any vacant cell or one which already has an entered value. It will not let you overstore a text cell or one which has a computed value; instead it refuses with:

```
Cell contents conflict...ENTER
```

To over-ride this protection, you must first use **[CTRL] Z** to clear the cell.

When a value is entered, it is immediately re-displayed in the target cell, but rounded and edited according to the style in force for that column. If the style is later altered to show greater precision, you will find that the entered value has retained the full precision.

Entering Text

Text can be written into any vacant cell, or into one already containing text. To signal that text is about to be keyed, use " (which is **[SHIFT] 2**). This initial double quote does not form part of the text, but subsequent keys are echoed directly into the current cell. The cell cursor shrinks as the text is keyed. To enter more text into the next column, just carry on keying. You can use **[DEL]** to backspace within the current cell, but there are no other editing facilities. To terminate your text, use **[ENTER]**. **[ESC]** can only undo the text in the current cell.

Text cannot be entered beyond the window right-most cell, nor can it cross into a cell which contains numeric data. In either case, MASTER-CALC waits for you to press **[ENTER]**.

Any cell has room for up to 8 characters of text. For wider screen columns, more text is possible, but it increases the storage requirement since MASTER-CALC builds overflow records to hold the extra text.

If a column width is reduced, it may cause truncation of text in that column, although expanding the column later will demonstrate that the truncated text is not lost.

Repeating Data

MASTER-CALC remembers the last-entered value, and you can ask it to reproduce this value at the current cell. This provides a handy time-saver when you wish to enter the same value in a series of cells. Use & (i.e.**[SHIFT] 6**) to copy the last entered value.

If you also switch on the auto-advance feature, then just by holding down the & you can rapidly fill a row or column, as far as the current window permits.

This copy feature works only for entered values, not for text or for computed values such as totals. However, with auto-advance switched on, repeating a total or formula reference is easy and fast.

Clearing Data

To reset one or more cells to its initial empty state, **[CTRL] Z** is provided, and it gives you the choice of:

```
CLEAR: Row/Column/Entry
```

Reply **R** to clear an entire row, or **C** to clear an entire column, or **E** to clear just one cell. In all cases, the cursor indicates the target cell(s). Clearing a row or column is complete, not just the part shown in the window.

MASTER-CALC will not let you casually enter values or text where it conflicts with current use of a cell, so you need **[CTRL] Z** to over-ride this.

Spare Memory Space

It can be useful to know how many spare bytes there are, and **[CTRL] S** tells you this, providing the message:

```
Spare bytes = nnnnn
```

Only with very large plans are you likely to have a space problem, but if MASTER-CALC does run out of memory it simply backs out of whatever request you made (such as inserting an extra column) with the warning:

```
No more room - ENTER (BEEP)
```

Inserting/Erasing a row or Column

There will be occasions when you need to insert a row or column, or remove one, analogous to using scissors and sticky tape on a paper plan. MASTER-CALC lets you do this easily, as follows. Start with **[CTRL] A**. You are then asked:

```
ALTER: array size Y/N
```

Press **Y**. (**N** is for other changes) The next question to answer is:

```
Insert/Erase
```

Press **I** if you want to insert, or **E** to remove. Then:

```
Row/Column
```

Press **R** for row, or **C** for column. Then:

```
Number:
```

Here MASTER-CALC asks where to insert or erase.

For erasure, give the number of the row or column to be erased.

For insertion, give the row or or column number to be inserted. For example, to insert a new column between 4 and 5, give the number 5. When a new column is inserted, the characteristics are taken from the preceding column. All newly created cells are empty. It is not possible to insert a new 1st row or a new 1st column. If there is insufficient room to extend the array, the following message is given:

```
No more room - ENTER (BEEP)
```

Altering Column Formats

When a plan is first initialised, column 1 is shown 12 characters wide, columns 2 onwards are shown 8 characters wide, and all values are shown rounded to the nearest integer. But with MASTER-CALC you can tailor each array column individually, or in ranges, in respect of:

a) display width in characters, minimum of 4, maximum of 24.

b) decimal places, minimum of 0, maximum of 7.

c) thousands commas (x,xxx,xxx) or not (xxxxxxx).

Because MASTER-CALC always stores data to the fullest precision, altering any of the above does not cause loss of data - although one can get display truncation if the display width is too small.

To make a change in format, start with **[CTRL] A**, and this yields:

```
ALTER: array size Y/N
```

Press **N**. (**Y** is used when altering the array size.) The next prompt is:

```
Width/Dec pl/Commas/Title
```

Reply with **W** or **D** or **C** and then you are asked for the range of columns to be affected with the change in format:

```
From column...:
```

Reply with first target column, then:

```
...To column:
```

and reply with the last target column. If only one column is to be affected then give the same number as before. Finally, respond to one of the following:

```
Width (4-24):
Dec. places (Ø-7):
Commas (Y/N)
```

Obviously, which prompt you get depends on which aspect of format you are altering.

After any change of format, the screen is re-drawn to reflect the change.

Giving the Plan a Title

In the top line of the plan display, above the column reference line, are two pieces of text. The left-most is the file name, given when the plan is saved. To the right is the plan title, which starts as:

```
MASTER-CALC by Campbell Software Design
```

Now, you can leave this piece of advertising there by all means, but you may put you own plan title here instead, and this can be up to 40 characters. To supply your own title, start with **[CTRL] A** which yields:

```
ALTER: array size Y/N
```

Reply **N** and then you will be asked:

```
Width/Dec pl/Commas/Title
```

Here you can press **T** to initiate a new title, and you will be asked:

```
Give plan title:
```

Key the title, up to 40 characters. If you key more, it will be curtailed. When you have given the new title, the screen is re-drawn.

Computed Data: Totals

Any cell can hold a value computed from other data in the plan. The commonest requirement is to generate a simple total of a row or column of values. All you need do with MASTER-CALC is to place the cursor where the total is required, and press **T**. You are then asked:

```
TOTAL: Row/Column/Accum
```

Reply by pressing **R** or **C** or **A**. After replying **R** or **C**, you are asked:

```
Sub-total/Full total
```

Reply F to get a full total, S to get a sub-total.

When you ask for a full row total, the program scans all cells to the LEFT in the SAME row, and adds together all values except other row totals. The result is placed in the target cell. For a row sub-total, the same applies except that the scan halts at and excludes the first other row total or sub-total.

When you ask for a full column total, the program scans all cells ABOVE in the SAME column, and adds together all values except other column totals. The result is placed in the target cell. For a column sub-total, the scan halts at and excludes the first other column total or sub-total.

Totals are calculated and shown immediately. However, should any of the data contributing to totals be changed, then recalculation of the totals is not done until **[CTRL] C** is used.

There is one other variety of total which MASTER-CALC offers, and this is the cumulative total. If we refer back to the prompt:

```
TOTAL: Row/Column/Accum
```

We have described the **R** and **C** responses above. **[A]** specifies that a cumulative total is required. The way this works is simply to store in the target cell the sum of the cell just above and the cell to the left. Thus if a series of cells either down or across is primed with **[T] [A]**, they form a series of cumulative totals of the adjacent column or row.

Computed Data: Formulae

A formula is an expression used to compute a value. Up to 99 formulae can be managed by MASTER-CALC, much more than you will be likely to need. An example of a formula is as follows:

```
R5C12*1.15
```

Which means 'the value in row 5 column 12, multiplied by 1.15'. 'R5C12' refers to a cell, '*' means 'times', and '1.15' is a literal number. Formulae can have any number of cell references, operators + - * / , numbers, and brackets ( ). '/' signifies 'divide', and operators * and / have precedence over + and −. The precedence of an operator determines the order in which the steps of a computation are done. Thus 2+3*4 yields 14, while (2+3)*4 gives 20.

Note that + and − can be regarded either as operators, or as a qualifying sign, when followed by a number. Thus you can write 'R5C12 * -1', which takes R5C12 value and multiplies by −1. A formula can start with a negative number, but it cannot start with, say, '**-R5C12**'. Instead you would start it with '**0-R5C12**'.

You may use brackets to force precedence or to make it clearer. Spaces can be embedded anywhere except within a cell reference. The maximum length of a formula is 75 characters.

In many applications, one requires to use essentially the same formula repeatedly along a row or down a column. This requires that column or row references within a formula be progressively modified, in order that the formula can be 'relocated'. With MASTER-CALC a system is used which we have not seen in other spread-sheet programs, and which is simple to operate. Consider the following formula:

```
R5*100/R12
```

This says 'compute row 5 times 100 divided by row 12'. In other words, find row 5 as a percentage of row 12.

But values are stored in cells, not rows or columns. What column is referred to in our example ? The answer is:

WHATEVER COLUMN THE FORMULA IS USED IN.

Here we have introduced the concept of a PORTABLE formula, which means that the same formula can be used UNCHANGED anywhere along a row or column.

What makes a formula portable is that it contains partial cell references, of the form Rnnn or Cnnn. Suppose you use a formula in column 20 of a row 3, referring to values in the same row, columns 6,7,8,10. It is best to use the partial cell references i.e. C6 C7 etc, rather than the absolute R3C6, R3C7 etc. Then you would be able to use the same formula in any row. Likewise, a formula with only row number references can be used in any column.

It turns out that most formulae that you will need can be made portable in this way.

A formula can contain an absolute cell reference and still be portable. For example suppose our plan contains the current dollar/sterling exchange rate in row 41 column 3. We may wish to use this exchange rate in our formulae, and we do so by coding the cell reference R41C3 (or C3R41). It would be inappropriate to alter this reference when using the formula at different cells.

How to Enter a Formula

Use display option **[CTRL] F**. It does not matter where the cursor is but you may find it clearer to place the cursor at an unused cell. You are prompted with:

```
New/Amend/Erase
```

Use N to indicate you wish to insert a new formula. You then are asked to give it a reference number:

```
Formula number 1-99:
```

This number will be used to connect a cell to a particular formula. We suggest you number your formulae from 1,2,3 etc. Give a number and then you are asked to give the formula:

```
Enter new formula...
```

Enter the formula at the small cursor below this message. You will find that left and right arrows, **CLR** and **DEL** all work in normal edit fashion. However, to achieve insertion, press up-arrow which inserts a space. **[ENTER]** when ready. MASTER-CALC immediately checks that the formula looks correct, e.g. balanced parentheses and cell references within range. If it finds an error, it offers the formula for re-editing:

```
Alter the following...
--- the formula ---
```

But you can **[ESC]** to force it in if you wish.

(It is unlikely, but possible, to get zero-divide at this stage, whereas when the formula is used at a cell, no error occurs.)

Altering and Erasing a Formula

Use **[CTRL] F**. Again, it does not matter where the cursor is. Reply to the following prompt:

```
New/Amend/Erase
```

We have already described the N response. Use A to alter, whereupon you are asked for the formula number:

```
Formula number 1-99
```

The formula is presented for editing, and further processing is as already described for new formulae. **[ESC]** can be used to back out, leaving the formula unchanged.

To erase a formula, reply **E** at the New/Amend/Erase prompt. You are asked for the formula number, and then to confirm the erasure, press **Y** when you see:

```
Press Y to confirm erasure
```

Press any other key to change your mind.

How to use a Formula

Position the cursor at the cell where you wish to store a value to be computed by a formula. Press **F**. You are asked for the reference number:

```
Formula number 1-99
```

Enter the appropriate number. MASTER-CALC immediately computes, stores, and displays the result. If auto-advance is switched on then the cursor advances to the next cell in the window.

Where to use a Formula

Generally, you can use a formula at any cell. But one must consider what happens if a formula refers to other computed data. Re-calculation of the whole plan is done row by row starting with row 1, and left to right in each row. Try to arrange your plan so that cells which use formulae refer only to computed cells which are earlier in the re-calculation sequence.

How to see which cells are Computed

Normally, your plan will only show text and values. But you may need to remind yourself which values are direct and which are computed. Simply press **[CTRL] T** and MASTER-CALC immediately high-lights every computed cell in the current window. Computed cells show one of the following legends:

RT	for a row total
RST	for a row sub-total
CT	for a column total
CST	for a column sub-total
CUM	for a cumulative total
Fnn	for a formula, where 'nn' is the formula number.

Press any key to proceed, and the indicated cells are restored to normal.

How to display a Formula

There are two ways. One is to start to alter the formula, as already described (see HOW TO ALTER OR ERASE A FORMULA), and then back out via **[ESC]**. The other way is to position the cursor over a cell where the formula is used, and press **[CTRL] F**, whereupon the formula is displayed at the bottom of the screen. Use **[ESC]** to proceed, and the formula will stay displayed until some other prompt re-uses that part of the screen.

Graphic Histograms

They say that a picture is worth a thousand words; so it is with spread-sheet data. The best way to see whether production is up or dowm, or what the trend is, or how sales respond to advertising outlay, is to draw a picture. With MASTER-CALC you can draw a graphic chart of up to three variables at a time.

You start by pressing **[CTRL] G**. The lower half of the screen clears and you are asked:

```
GRAPH: give 1st row to plot
```

Reply by giving the number of the row whose values you wish to plot. Then:

```
Give 2nd row, if any
```

Reply with the second row number, or **[ENTER]** if only one variable is needed.

```
Give 3rd row, if any
```

Reply with a number, or **[ENTER]**

When you have told MASTER-CALC which rows to plot, it swiftly draws the histogram, showing one set of bars for each array column in the current window, and aligned with each plan column. The first row variable is plotted in solid, the second (if any) in outline, the third (if any) in a mid tone.

The chart is automatically drawn to a scale to accommodate the highest value, and the lowest value (or zero if all plots are above zero). Any negative values are plotted downward from a raised baseline.

For each row plotted, a key is given, annotated by taking any text from column 1 of the row. Column 1 would normally be a descriptive label.

The following prompt asks if another chart is to be drawn:

```
Another ? Y/N
```

Reply **Y** or **N** accordingly. If you reply **N**, the whole screen is restored to the way it was before **[CTRL] G** was used.

The number of plots is geared to the number of columns in the window. To show more array columns on a chart, you can temporarily reduce the display width of the columns, so that more will fit on the screen.

Note that if you draw a graph, then move the window across, and draw another graph, the vertical scales are not likely to be the same, since this is adjusted dynamically to the range of values on display at each time.

Any value which is very large compared with the other values plotted, may render the histogram useless because it will show just one column, the others being scaled down to vanishing point. A practical case may be a set of monthly columns followed by a year-total column. The year-total is best excluded from the graph to retain a useful height of the monthly data. If necessary, alter column widths or use column overlay technique to hide the unwanted column.

For reference purposes, it is useful to have at least one of the plotted rows visible in the top of the screen. But it is not essential.

If you are using a split window, be sure to switch to the upper window before you use **[CTRL] G**; otherwise, the graph will reflect the column map of the lower window which may not be in step with the upper window.

In theory, a spread-sheet can be drawn up with its dimensions reversed, but the conventional aspect of a plan which has time as one of the dimensions is to make the the horizontal aspect. If you feel that you could equally use your plan one way up or the other, bear in mind that MASTER-CALC graphic histogram can only show row by column, and not vice versa.

Screen Snapshot

An 'unofficial' command, not shown in the **[CTRL] K** menu, is **[CTRL] Ø** (zero). This gives a high-resolution copy of the screen, provided you have an Epson or Star or equivalent printer attached. (Sorry, not the DMP-1). You may Use **[CTRL] Ø** at any time, but this is especially useful whilst the histograms are on the screen. Note that this screen copy is slow, about 3 minutes. To curtail or back out, hold **[ESC]** down.

Printed Output

(See also previous paragraph)

Although some say that one day electronic communications will create a paper-less society, the fact is that today we still like to be able to get a 'hard-copy' from the computer, to send to a colleague or to the boss, or to puzzle over in our easy chair, or to file for reference.

So it is that if you have a printer then you will likely wish to make a printed version of your MASTER-CALC display. Here we have a problem, in that your printer is limited in that although it can print the full plan depth, onto continuous paper, it may not be able to handle the full width of your plan. MASTER-CALC offers a variety of printing schemes to solve this problem.

Use **[CTRL] P** to select the print function. You will see the prompt:

```
PRINT: row/col numbers to show Y/N
```

Whilst the grid reference lines are useful on the screen, they can be suppressed on the print-out, by replying N here. Otherwise, reply **Y**.

Next, MASTER-CALC gives you an opportunity to send control characters to your printer. It asks:

```
Printer control code:
```

Press **[ENTER]** if you do not want to send any. Otherwise, for each code you want to send, enter its decimal value (0 to 127) and press **[ENTER]**. When no more codes are to be sent, press just **[ENTER]**.

Not all printers use the same set of codes, so you must check your printer manual for what values to send. But as an example, Star and Epson dot matrix printers can be sent code 14 and 15 to signal a double-width title and condensed (17 cpi) mode, respectively. Condensed mode is obviously useful for wide spread-sheets.

Next, you are asked to give the printer width in terms of how many characters per line it can handle. This depends on the pitch, which you can select on some printers as we have just discussed. For example, an 80-column Star can print 132 characters per line in condensed mode. The width determines how many array columns can be printed. The prompt is:

```
Printer line width:
```

Reply with any number from 40 to 240, or just use **[ENTER]** to signal a default of 80 printer characters.

Finally, reply to the prompt:

```
Stop after row:
```

[ENTER] defaults to the last row of the plan, but you can enter a number to make it stop printing after any particular row number.

MASTER-CALC then prints your plan according to the following rules:

a) Rows 1 and 2 are always printed.

b) The next row printed is the third one shown in the current window.

c) Further rows follow, until the last or earlier if a 'stop after' value has been given.

d) Within each row, the first two columns printed are those shown in the current window.

e) Further columns are selected following from the second one displayed. Thus if columns 4,6,10 etc are displayed, 4,6,7,8 etc are printed.

f) When there is not enough room to print a full column, or if there are no more columns, printing of that row is curtailed.

Note that for wide plans, a full print must be done in stages, each stage printing a page of columns. If you are filing the sheets separately, then you probably want column 1 to repeat on each page. On the other hand, you may wish to tape the pages side by side, so that column 1 repeat is not required. You can use the **L** and **O** functions to display pages without plan column 1, in preparation for printing.

For deep plans, you can print continuously - crossing the perforation lines of fan-fold stationery. Alternatively, you can print separate pages vertically by giving a 'stop-after' row number when prompted. Title and rows 1 and 2 are always printed, irrespective of the postition of the window.

If you make several print runs, as long as the printer has not been switched off or used by another program, there is probably no need to repeat the printer control codes after the first time. However, a notable exception is the double-width code (14) which turns itself off as soon as the title has been printed. (Printers forget 14 once they are sent a CR; this is how only the title line gets the double-width treatment.)

Cancelling a print request

MASTER-CALC will sit waiting forever if your printer is off, non-existent, or just plain unready. Ready your printer, or else rescue MASTER-CALC by holding down the [ESC] key until it responds.

Sterling symbol

The pound-sign is sent as code 35, which many printers show as '£'. If your printer needs a different code then you must POKE the code as follows:
a) Exit to BASIC via top menu and X.

b) POKE 4322,xxx [ENTER]

c) GOTO 100 [ENTER]

... where 'xxx' is the decimal code (not greater than 127) which your printer takes as pound-sign.

Recalculation of Computed Values

When a total is declared (via T), or when a formula is used (via F), the target cell is computed and shown immediately. But when data in the plan is altered there is no automatic recalculation of dependent cells. The reason is that this could slow down the data entry process. Therefore, it is the user's responsibility to ask for recalculation and this is where [CTRL] C is used.

Recalculation is performed on all total and formula cells, row by row from row 1, and left to right in each row. Whilst this takes place, the message is shown:

```
--- Calculating ---
```

This may take less than a second, or it may take up to a minute or more, depending on the number and degree of the computations. For example, integer arithmetic is generally much faster than fractional arithmetic.

On completion, the entire screen is redrawn showing any changes.

There may be situations where one needs to recalculate twice, notably where formulae are used which refer forwards to other values which can themselves alter later in the recalculation process.

Numeric Overflow

There are several kinds of overflow conditions, some more serious than others.

There is no gap between the plan columns, so values which fill a column will touch the neighbour on its left, which can look untidy. Ideally, it is best to arrange columns so as be at least two characters wider than the largest value to appear.

If a value is wider than the display format allows, then it is curtailed at the left, with the left-most character highlighted with reversed paper/pen. This therefore signals that at least one character has been suppressed. The way to view the whole of the cell is to widen its column. Please note that this signal is not possible on the printed hard copy.

If a value is greater than 9999999999999999 (sixteen nines), then it is deemed to be erroneously large and is shown as a *. Note that it is not possible to enter a value larger than this directly, so such overflows are possible only by means of total or formula use. The internal format (eight-byte floating point) of MASTER-CALC values allows much larger numbers, up to ten to the power of 38 or so. Any values shown as * are below this internal maximum, and may be used correctly within formulae.

If a value would overflow the internal maximum value, then MASTER-CALC warns audibly with a BEEP, and the value is set to zero. If this happens during a recalculation, the row and column of the offending cell are shown:

```
Error in row xxx col yyy (ENTER)
```

A common cause of 'hard' overflow will be division by zero, perhaps processing a formula when cells referred to have not yet been given values.

When a formula is entered or altered (via [CTRL] F etc.) then any cell reference is deemed to retrieve the value of 1 for the purpose of validation of the formula. This prevents zero-divide overflow in the event that values to be used have not yet been entered into the plan.

Very Small Numbers

Due to rounding, values greater than zero may show as 0. There is no way to differentiate between such zeros and real zero values, except that small numbers which show as zero still operate correctly when used in formulae and totals.

The smallest number above zero which can be displayed is 0.0000001, since 7 is the maximum number of decimal places.

The smallest number internally is about 10 to the minus 38.

Negative Numbers

These show a minus sign to the left. The absolute range is the same as for positive numbers, but of course negative numbers need an extra character of width to accommodate the sign.

Apparent Arithmetic Discrepancies

Because MASTER-CALC always rounds values "at the last moment", it is very accurate in computation. However, a side-effect may be an apparent inconsistency as the following example illustrates:

Two values of 1.3 and 3.4, will appear as 1 and 3 respectively, if integer format is used. But their total (4.7) will be shown as 5. Thus the plan would apparently show that 1 + 3 = 5. Of course, if more decimal places are given in the format then the discrepancy in this example vanishes.

Program Back-up and File Transfer

You should consider taking a back-up copy of MASTER-CALC for security. If you have a disc system then you can use the CPM utilities for this. For cassette users we suggest taking a copy at high-speed for everyday use.

Taking a back-up copy for your own security or to transfer to disc is permitted. However, you are reminded that TRANSFER OF ANY COPY OF THE PROGRAM OR MANUAL TO A THIRD PARTY IS A BREACH OF COPYRIGHT.

To Save Master-Calc

a) Load MASTER-CALC, but DO NOT INITIALISE OR LOAD A PLAN YET.

b) X to BASIC.

c) SPEED WRITE 1 [ENTER] if required.

d) GOTO 200 **[ENTER]**

Line 200 of the BASIC saves the BASIC loader program with the name MCALC, and the machine code program with the name MCALCODE.BIN

To transfer MASTER-CALC from tape to disc

a) I TAPE **[ENTER]**

b) Load MASTER-CALC from tape, but DO NOT INITIALISE OR LOAD A PLAN.

c) Press D, then A or B (or ENTER if just one drive).

d) Press X to reach BASIC environment.

e) GOTO 200 **[ENTER]**

To transfer a plan file from tape to disc

a) Load MASTER-CALC

b) T to switch to tape mode

c) L etc to load the plan from tape

d) **[CTRL] X** to top menu

e) D etc to switch to disc mode

f) S etc to save the file to disc

Colour Trim

Although there is a colour trim via top menu * option, you can also set the default colours by altering line 90 of the BASIC program. You may wish to do this before making a program save.

File Structure

It is not necessary for you to know how MASTER-CALC stores your plan, and you can skip this chapter. For those readers who are interested, here are a few notes.

The plan array is the main memory user, each cell comprising nine bytes of which the first indicates the kind of cell content, being one of:

a) Unused
b) Directly-entered value
c) Cumulative value
d) Row total
e) Row sub-total
f) Column total
g) Column sub-total
h) Text (1-8 characters)
i) Text (8 characters, linked to overflow record)
j) Value computed via a formula

The next 8 bytes of each used cell are either text. or a floating point number of which 1 byte is exponent and 7 are signed mantissa.

Following the main array in memory is a list of column specifications, two bytes for every column, of which the first byte in each pair gives the display width of the column, and the second gives the number of decimal places and whether or not commas are to be displayed. This list explains why a 10 x 200 array takes more space than a 200 x 10 array.

Following the column specifications are the text overflow records, containing overflow text for cells type i) above. They are identified with row and column reference.

Next are the formulae, identified by their reference number, 1-99. They may be stored in any order.

The memory requirements of a plan depend not only on the number of cells, but the number of columns, and the number and size of text overflows and formulae.

When a plan is saved and loaded, the above components are included, but also such data as:

File name and plan title
Colour trim
Array dimensions
Window disposition - everything except mode and exact cursor position.

In the event that there are later versions of MASTER-CALC, we will ensure that plans created by this version will be usable.